An Introduction to Finance

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Financial Instruments

- The instruments analysed during the course belong to the broad category known as **securities**

- **Security**: a fungible, negotiable financial instrument representing financial value

Security types

- Three main types of securities:

    - **Debt**: securities that are «secure» in the sense of being *«risk-free»* (e.g. bonds, commercial notes, and bank deposits)

    - **Equity**: usually company's *stocks* or a share value

    - **Derivatives**: securitires whose value depends on the value of others more basic underlying variables (e.g. *futures* and *forward* contracts, *swaps* and *options*)

        - A stock option is a contract whose value depends on the price of a stock at a certain date

- Securities are usually traded at organized markets known as **exchange markets**

Examples of exchange markets

▶ For stocks and options:
  ▶ New York Stock Exchange (NYSE), Chicago Board Options Exchange (CBOE), Nasdaq, London Stock Exchange (LSE), ...

▶ **Bonds** are usually considered as the benchmark risk-free security in financial engineering

▶ ... we start with a brief review on bonds and the **computation of the profit** obtained by these securities...

▶ ... and then we focus on stocks and options!

Bonds and interests computation

- A bond is a long-term loan contract between two parties:

    - the **issuer** (aka borrower or debtor) – who receives a specified amount of money from the holder

    - the **holder** (aka lender) – who will be paid back by the issuer, at a later date, together with some interest

- The interest could be paid at various fixed points during the life of the bond

    - **Principal** is the amount given by the lender, **coupons** are the successive interest payments

    - **Maturity date** is the date the bond expires

Bonds and interests computation

▶ Thus, the value of a bond depends on the **time to maturity** and the **interest rate**, as well as the **frequency of payment of the interests**

▶ Suppose that an investor acquires a bond with a principal of 100 € at an annual interest rate of 10%. The value of the bonds after one year will be:

$$100 € + (0.1 \times 100 €) = 100 € \times (1+0.1) = 110 €$$

▶ In this case, the value of the bond depends only on the interest rate, but what does happen with a longer maturity and more frequent payments?

Compunding of Interest Rates

▶ Consider the previous case, but with a maturity of n years

  ▶ At the end of the first year, we (already) know that the bond value will be 110 €

  ▶ Now the interest earned so far is added to the current value of the investement and the next interest is computed over the resulting sum

  ▶ Thus, after the second year the value of the bond will be:

$$110 € + (0.1 \times 110 €) = 110 € \times (1+0.1) = 121 €$$

  ▶ Or, equivalently, starting from the principal:

$$100 € \times (1+0.1)^2$$

▶ Therefore, the **general formula for compounding the interest rates** is:

$$P_n = P_0 \ (1+r)^n$$

  ▶ Where P_0 is the principal, r is the annual interest rate and n is the maturity (in years)

Considerations

▶ Increasing the frequency of payment of the interest, say *m>1* times in a year, then the fraction of the annual interest rate, which is compounded at each shorter period, is *r/m*

$$P_n = P_0 \ (1+r/m)^{nm}$$

▶ The following table summarizes the effect of more frequent payments of the interests

Table 1.1 The effects of compounding frequency on €100 over 1 year at the interest rate of 10% per annum

Frequency	Number of payments (m)	Interest rate per period (r/m)	Value at the end of year
Annual	1	0.1	€110.00
Semiannual	2	0.05	€110.25
Quarterly	4	0.025	€110.381
Monthly	12	0.0083	€110.471
Weekly	52	0.1/52	€110.506
Daily	365	0.1/365	€110.516

Payoff and profit of bonds

▶ The **payoff**, of any security, is its value at maturity

▶ Payoff of a bond is the principal plus all the interests

▶ The **profit** of a security is its risk-adjusted payoff discounting the initial investment, which includes contract fees or any other transaction costs

▶ For bonds there are usually no transaction costs or fees (or if there were, we can assume them to be included in the principal) and the risk is null; hence, the profit of a bond is simply computed by discounting the principal to the payoff:

$$P_\tau - P_0 = P_0 (1+r/m)^{m\tau} - P_0 = P_0 ((1+r/m)^{m\tau} - 1)$$

Continuous Compounding

▶ To model pricing behaviour of stocks and options, or any other security whose value is frequently changing, it is convenient to consider the trading can be done continuously in time

▶ When we consider risk-free securities (e.g. bonds) we assume that interests are computed infinitely often (i.e. m tends to infinity) over a generic time period $\tau > 0$ which could be n years as well as an infinitesimal step

▶ The formula to compute the continuously compunded interest is:

$$P_\tau = P_0\, e^{\, r\, \tau}$$

▶ If we consider the previous example, the value after 1 year, with continuously compounding, is $100\, e^{\, 0.1} = 110.52$ € (which is really near to the daily compounding)

Continuous Compounding

▶ More generally, if P_t is the value of the bond at time t, the value at a later instant $t+\tau$ with continuous compound is:

$$P_{t+\tau} = P_t \, e^{\, r\tau}$$

▶ And to recover the value at a previous instant $t-\tau$ we have:

$$P_{t-\tau} = P_t \, e^{\, -r\tau}$$

Stocks: Trade, Price and Indices

- A share of a company's stock is a claim on part of the company's assets and earnings

- Two types of stock:

  - **Common** – usually entitles the owner to vote at the shareholders' meetings and to receive dividends

  - **Preferred** – generally does not give voting rightsm but have priority over common stock regarding payment of dividends

- …as the name suggests, common stocks are the most… common

Stocks

▶ A company sells shares or participations to raise more capital. Shares are sold to the investors through stock exchange markets (*company's shares outstanding*)

▶ **Market value/capitalization** of a company:

> *number of shares outstanding* x *price of a share*

▶ Market value of a company varies through time according to price

▶ Every shareholder has a «partial» ownership of the company, defined by the number of shares owned relative to the shares outstanding

Stocks

- In the figure, an 1880 certificate for 500 shares of Wells Fargo Mining Co.

- Nowdays, stocks are brought in person or electronically, through financial institutions with brokerage services, facilitating the transactions of stocks between buyers and sellers

- Brokers are the ones responsible for executing the buy or sell orders at the stock exchange, as instructed by their clients

Buy and selling stocks

▶ Buy and sell orders are regulated by the market authority and have different forms to allow for (as well as forbid!) different trading strategies

▶ Three common forms for buy and sell orders:

  ▶ **Market order**

  ▶ **Limit order**

  ▶ **Stop order**